TEXTO PARA DISCUSSÃO Nº 94

HIGH TECHNOLOGY AND NEW INDUSTRIAL AREAS IN BRAZIL: THE DEVELOPMENT OF SÃO JOSÉ DOS CAMPOS AND CAMPINAS CITIES

Clélio Campolina Diniz
Mohamad Razavi

Novembro de 1995

Ficha catalográfica

338.45(81) D585h 1995	DINIZ, Clélio Campolina. High technology and new industrial areas in Brazil: the development of São José dos Campos and Campinas Cities. 50p. (Texto para discussão/CEDEPLAR; 94) 1. Brasil - Indústrias - Inovações tecnológicas. 2. São José dos Campos (SP) - Indústrias. 3. Campinas (SP) - Indústrias. I. Razani, Mohamad. II. Título. III. Série. VI. Universidade Federal de Minas Gerais. Centro de Desenvolvimento e Planejamento Regional

UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE CIÊNCIAS ECONÔMICAS
CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

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Clélio Campolina Diniz
Centro de Desenvolvimento e Planejamento Regional/ CEDEPLAR - Universidade Federal de Minas Gerais

Mohamad Razavi
Project on Regional and Industrial Economics - Rutgers University

CEDEPLAR/FACE/UFMG
BELO HORIZONTE
1995

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Clelio Campolina Diniz
Centro de Desenvolvimento e Planejamento Regional-CEDEPLAR
Universidade Federal de Minas Gerais

and
Mohamad Razavi
Project on Regional and Industrial Economics
Rutgers University

June 1995

This research was funded by grants from National Science Foundation-N.S.F. and Fundação de Desenvolvimento da Pesquisa de Minas Gerais-FAPEMIG, although the findings remain our own.

SUMÁRIO

I - INTRODUCTION:

The rapid industrialization of a number of developing countries during the past three decades has been associated with particular spatial patterns. The most important spatial pattern, long preoccupying policy makers and academics alike, has been the excessive concentration of manufacturing activities and the associated emergence of primate cities. In more recent years, evidence gathered by scholars in various countries points towards the weakening of trends towards further polarization. In Latin America for example, Portes (1989) has drawn attention to the lowering of primacy rates in twelve out of fifteen primate cities during the 1980s. Contributing to such a trend has been the rapid growth of non-primate and secondary cities in a number of countries making the understanding of their developmental path a new focus of analysis.

Paradigms that shed light on the dynamics of non-primate city growth can be grouped into the following three groups: a) those emphasizing the reversal of the forces of polarization due to the rising costs of doing business in primate cities (Richardson 1980); b) analysts that point to the dynamism of new industries and new technologies in "creating" new regions (Storper 1992, Borello 1993); and c) authors that highlight the importance of global processes leading to the collapse of import-substitution industrialization model, partial desindustrialization of core areas, and the rise of flexibly specialized industrial organization (Portes 1989, Katz 1992, and Murray 1992).

While we acknowledge the importance of the forces of polarization-reversal, particularly in the case of the metropolitan area of Sao Paulo in Brazil, and of international movements of capital and technology, the focus of this study is on the contribution of institutions. The chapter analyses the role that such institutions as the state, multinational, state-owned and national firms, universities and research organizations have played in the emergence of Campinas and Sao Jose dos Campos, both in the interior of Sao Paulo state. In addition, we will examine the importance of professional labor market, local and non-local linkages, and the locational proximity to developed industrial centers, especially São Paulo. The impact of recent industrial restructuring and market reform policies on the performance of Campinas and Sao Jose dos Campos (SJDC) and on their developmental prospects will also be studied.

Campinas and Sao Jose dos Campos (SJDC) were chosen because, in terms of industrial value-added and employment, they have been the most dynamic areas in the interior of the Sao Paulo state during the 1970s and 1980s (Diniz and Crocco 1995). At the same time, as high-technology related centers of R&D and production, Campinas and Sao Jose dos Campos (SJDC), following Sao Paulo city, have been the top two most important cities in Brazil.

In sections two and three, we will offer a number of hypotheses and provide an historical account of the spatial dimensions of industrial development in Brazil and the place of Campinas and SJDC in that process. The results of our fieldwork in Campinas and SJDC will be presented in the following

sections and we will conclude by reflecting on the possibilities and constraints of state-sponsored technopoles in Brazil and the lessons that can be learned.

II - THEORETICAL AND CONCEPTUAL ISSUES:

Since the mid-1970s, two issues in the industrial development of semi-industrialized nations have been prominent: the development of intermediate and capital goods sectors, and catching up with information technologies. The States in semi-industrial nations have generally played a prominent role in achieving these objectives. Through such mechanisms as industrial and trade policies, States have helped the integration of a number of mature industries into their national economies and have fostered industries based on new technologies (Amsden 1989, Castro and Souza 1985, Kaplinsky 1989). A number of such States (Brazil, South Korea, Argentina) were military-ruled during 1960s and 1970s and were highly preoccupied with national security issues. Consequently, they supported strategic industries such as telecommunications, advanced electronics, and in a number of cases nuclear and aerospace industries (Adler 1987, Schwartzman 1991).

Another instrument, part of the policy lexicon of states in developing nations during the period under discussion, was regional policy. Concerns with over-urbanization, widening inter-regional gaps and geopolitical issues, moved the States in these nations to try to achieve a measure of deconcentration in the prevailing industrial location patterns.

The fast growing non-primate cities in semi-industrialized nations have emerged within the above industrial and regional contexts. In what follows, we will offer a number of hypotheses about the combined impacts of influential economic forces and state activities on locational proclivities of manufacturing. Thus we are opting for an inductive approach. The reason for such an approach is that we find the existing conceptual treatment of the spatial development of industries in semi-industrial nations inadequate for our task. In the polarization-reversal approach the activist role of the state plays a marginal role and it is the push factors that dominate the research agenda. The New International Division of Labor thesis, while applicable to such cases as Mexico's Maquiladoras or the Export Processing Zones of SE Asian economies, hardly corresponds to the experience of inward-oriented Latin American economies. And the emphasis in the flexible specialization approach on the role of small and medium-sized firms and the local institutions that support them in penetrating export markets, refer to industrial patterns that are marginal in the overall scope of industrialization in semi-industrial nations particularly in relation to the development of intermediate and capital goods sectors and high-technology industries (Markusen and Park 1994).

The above, we hope, justifies our inductive approach which we will pursue by offering a number of hypotheses drawn from the general literature on industrial development in the NICs with the necessary reformulation to respond to our locational interests. First, the emergence of high-technology-based agglomerations are directly linked to state industrial and trade policies. Local specialization is emphasized which helps the necessary localization economies but leaves the city

vulnerable to demand fluctuations and, in the case of protected markets, to shifts in trade policy. Second, unless there is an overwhelming national security concern, the high-technology-based poles are usually placed in proximity to major cities in order to benefit from the agglomerative fields and the markets of large cities. Third, the shortage of engineering and high-skilled manpower in developing countries makes the establishment of specialized universities and research institutes an important ingredient of the development of technology-based poles. Their success in developing the necessary human resources and further in-migration of professional labor contribute to attracting industrial firms. Local conditions in terms of infrastructure, appropriate land and supply of fresh water are also important considerations.

In terms of linkages the following hypotheses will be explored: More important than the capital goods sector, the presence of large, diversified firms and public-private institutions are essential for inter-industry technology diffusion. In the absence of such organizational capacities, state-led entry into high-technology industries results in weak linkages between high-technology and mature industries. Second, in a technology-based agglomeration, state involvement in various aspects of education, R&D, manufacturing, and demand provision can lead to strategic weakness. Similarity of visions, a commitment to a singular technological trajectory, and a politically-biased reading of market information and signals contribute to what has been called the "weaknesses of strong ties".

In terms of the impact of recent market reform policies we hypothesize that these policies in semi-industrial nations are forcing new strategies on firms, making them more competitive at the same time that such policies are weakening domestic and local linkages in supply lines and technology acquisition.

III - BRAZILIAN INDUSTRIAL AND REGIONAL DEVELOPMENT:

Industrial production in Brazil started in the second half of the nineteen century. The initial pattern of industrialization had a decentralized character since it was linked to the ongoing model of accumulation, the "primary export model", in which various regions were isolated from each other but directly linked to the international market. As a result the infra-structural connections among regions were almost non-existent and the internal market was highly underdeveloped (Castro, 1975; Suzigan, 1986; Furtado, 1966).

Since the middle of nineteenth century the production of coffee grew rapidly, spread mainly to São Paulo plateau, and became the most important economic activity in Brazil. Coffee production generated revenues, demand for consumer goods and urban services, and surplus which was transferred to other activities. Due to such factors, population and industrial production started to concentrate in the state of São Paulo, mainly in the city of São Paulo, towards the end of the nineteenth century (Cano 1976, Dean 1976, Silva 1976, Mello 1982).

After this period, coffee production experienced a number of crises, the most important of which was related to the international crisis of 1929. The severity of that experience expedited the transformation of the accumulation model from the primary export model to import-substitution industrialization. During the next three decades, and primarily due to various government initiatives, the industrial structure became more complex with heavy industrialization, and a great inflow of foreign capital which was invested mainly in the consumer-durable industry (Benevides, 1976; Malan et all, 1977; Villela and Suzigan, 1973).

The economy of the state of São Paulo highly benefited from the import-substitution industrialization process. The state's share of industrial production in the nation increased from 16% in 1907 to 45% in 1939, and to 58% in 1970 (table 1), the peak of concentration, with the Metropolitan Area accounting for 39% of that production (Cano, 1976; Dean, 1976).

TABLE 1
BRAZIL: RELATIVE SHARES OF REGIONS IN INDUSTRIAL PRODUCTION
1970-1990

REGIONS	1907	1939	1950	1970	1980	1990
North	4.3	1.1	0.6	0.7	2.4	3.1
Northeast	16.7	10.4	9.3	5.7	8.1	8.4
East	42.3	28.9	28.9	22.7	19.2	20.0
São Paulo State	15.9	45.4	46.6	58.1	53.4	49.3
- Metropolitan S.P.		(27.8)	(29.8)	(39.0)	(30.5)	(26.0)
South	19.9	13.8	14.0	12.0	15.8	17.4
Center-West	0.9	0.4	0.6	0.8	1.1	1.8
Brazil	100.0	100.0	100.0	100.0	100.0	100.0
Brazil (less S.P.)	84.1	54.6	53.4	41.9	46.6	50.7

Source IBGE, Censos Industriais and for 1990, authors' estimation

In the aftermath of the economic crisis of the 1960's, which has been linked to the decline of the import substitution model (Tavares, 1974), the Brazilian Government opted for an ambitious industrial policy based on developing intermediate and capital goods and improving technological capability. As the international conditions were favorable, foreign capital rushed to Brazil either as direct investment or as loans to private and public sectors. The industrial employment in Brazil increased from 2.7 millions to 5.7 millions between 1970 and 1980, in which intermediate, capital goods and consumer-durables were the leading sectors (table 2). In the eighties the economic conditions deteriorated in the aftermath of the second oil shock, the fiscal crises, the rise of international debt and inflationary pressures.

TABLE 2
BRAZILIAN INDUSTRIAL STRUCTURE AND EMPLOYMENT (1939-1980)

SECTOR	YEARS			
	1939	1959	1970	1980
Mines	**4.2**	**2.5**	**2.4**	**1.7**
ND Consumer(1)	67.9	52.1	45.6	39.0
Intermediate (2)	23.5	32.0	32.9	33.5
CG & CD (3)	4.3	13.4	19.2	23.3
All Industry	**100.0**	**100.0**	**100.0**	**100.0**
Total Employment ('000)	**781**	**1,799**	**2,700**	**5,720**

SOURCE IBGE. Estatísticas Históricas do Brasil - Séries Retrospectivas Econômicas, Demográficas e Sociais (1950 a 1985)

(1) Non-Durable Consumer Goods

(2) Intermediate Goods

(3) Capital Goods and Consumer Durables

With the boom of the seventies, a number of transformations took place in Brazil. First, cost of production within the metropolitan Sao Paulo rose as a direct result of the industrial concentration process. Subsequently, many new enterprises located outside of, but not far from, São Paulo City. Secondly, Federal and State governments initiated policies to achieve modern technological capabilities and industrial deconcentration. Beyond these, the search for natural resources, taking advantage of fiscal incentives and developing new markets took many companies to other locations. So, a process of polarization reversal was set in motion and the share of São Paulo metropolitan region in the industrial production dropped from 39% to 26% of the Brazilian industrial production between 1970 and 1990, and from 34% to 22% of industrial employment between 1970 and 1991.

With the start of the deconcentration process mature industrial activities moved to many regions in Brazil. However, with the onset of technical change and emergence of information technologies this movement weakened and was primarily restricted to a polygonized area from Minas Gerais to Rio Grande do Sul (Diniz, 1993). Accordingly, the cities in the interior of São Paulo state became locational alternatives for new industrial agglomerations based on modern technologies. Among such locations the development of Campinas and São José dos Campos is of particular importance. Industrial employment in the Campinas region increased from 42 thousand in 1970 to 104 thousand in 1980. São José dos Campos' industrial workforce more than doubled, from 18 thousand to 45 thousand, in the same period (table 3). Even during the economic downturn of the 1980s, both cities

were able to generate new jobs, though at a much slower pace. The peak of manufacturing employment in SJDC, not indicate in Table 3, was in 1988 when it reached 64 thousand employees (Prefeitura Municipal de São José dos Campos, 1994).

TABLE 3
SÃO PAULO CITY, CAMPINAS, AND SÃO JOSÉ DOS CAMPOS: POPULATION AND MANUFACTURING EMPLOYMENT

YEAR	POPULATION (Thousands)			MANUFACTURING EMP. (Thousands)		
	São Paulo	Campinas	S.J.Campos	São Paulo	Campinas	S.J.Campos
1874	31	31	15	-	-	-
1900	239	68	18	-	-	-
1940	1.326	130	36	174	7	2
1960	3.781	217	77	464	16	6
1970	5.925	502*	148	644	42*	18
1980	8.493	951*	288	1.114	104*	45
1991**	9.627	1,373*	442	869	118*	46

SOURCE IBGE. Censo Industrial, several years. IBGE, Censo Demográfico, several years.
(*) The data for Campinas since 1970 are based on the following municipalities wich are within a 25 km radius: The cities of Campinas, Indaiatuba, Jaguariúna, Nova Odessa, Paulinia, Sumaré, Valinhos and Vinhedo.
(**) Employment data for 1991 are based on Ministério do Trabalho, Relatório Anual de Inf. Sociais, 1991.

The forces contributing to the emergence of these cities as new industrial agglomerations and centers of high-tech activities will be analyzed in what follows[1].

[1] More than thirty firms, 2 universities, 5 research labs, and a number of public and private agencies, and unions were interviewed for this project between July and September of 1993. In May and June of 1995, we visited a number of them again to update our information.

IV - CAMPINAS: RESEARCH METROPOLE OR HIGH-TECH ASSEMBLY?

IV. I - *Historical background and locational attributes*[2]

The city of Campinas, located 90 km north-west of the city of São Paulo, emerged in 1790's during the "São Paulo sugar cycle". Around 1840, coffee reached the region and for the rest of the century the city's gradual development was linked to coffee production. During this period several important enterprises belonging to local coffee farmers and a number of industries related to consumer goods and agricultural products were established. Campinas and its surroundings became the state's most important agricultural region, trade center, rail junction and gate to the west of São Paulo, and was thus called the "agricultural capital". However, the city's urban functions could not compete with those in the city of São Paulo. Between 1874 and 1900, while the population of Campinas increased from 31 thousand to 68 thousand inhabitants, the city of São Paulo experienced an extraordinary population growth from 31 thousand to 239 thousand, to which foreign immigrants made an important contribution (Table 3; Cano, 1976). The same pattern of population growth continued during the first half of the twentieth century with Sao Paulo surpassing 3.8 million inhabitants in 1960 while Campinas claimed a population of 217 thousand.

The paved road from São Paulo to Campinas, finished in 1948, and Brazil's rapid industrial development during the 1950's brought a number MNCs such as Rhodia, 3M, Singer, Bosch,

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[2] Information in this section are based on Semeghini (1991); Cano (1977) and Mello (1982)

Merck and Sharp to Campinas. On the other hand, the presence of several important agricultural research centers and the decision to locate a State university, Universidade Estadual de Campinas (UNICAMP), in the city in 1962 contributed to the development of a research environment in Campinas. Later, UNICAMP acted as an important anchor in attracting several national research facilities in telecommunications, informatics, and new materials to the city.

Beyond the universities and research facilities that have contributed to the pool of professional labor, rapid expansion of manufacturing activities since 1950s, the proximity to São Paulo city, construction of an international airport and other transportation networks, availability of flat land, fresh water and a pleasant cultural and social environment have turned the region into a suitable alternative for industrial location, particularly in the high-tech sector.

IV.II - *The Region*[3] *of Campinas: Recent Population Growth and Occupational Structure*

Campinas has been the fastest growing region in the interior of São Paulo State and has acted as the central city for the surrounding municipalities. The population of the city of Campinas increased rapidly from 336 thousand in 1970 to 825 thousand in 1991. Considering the Campinas region, its population increased from 415 thousand in 1970 to 1.3 million in 1991, multiplying more than three times, with some municipalities growing more than fifteen times during that period (table 4).

[3]To analyze the industrial development of the Campinas region we will consider the following eight cities (Campinas, Indaiatuba, Nova Odessa, Paulinia, Sumare, Jaguariuna, Valinhos and Vinhedo) that are almost integrated, located within a radius of less than 25 km, and have the same labor market and infrastructure.

TABLE 4
CAMPINAS REGION: URBAN POPULATION
1970-1991

CITY	1970	1980	1991
Campinas	335756	591557	824924
Indaiatuba	22341	48484	91849
Jaguariúna	3839	9278	19087
N. Odessa	6242	19538	31973
Paulínia	3673	19085	32907
Sumaré	15295	95808	225528
Valinhos	19963	37458	59912
Vinhedo	7420	21043	32999
TOTAL	**414529**	**842251**	**1319179**

Source IBGE - Censo Demográfico, several years.

Data on the occupational structure of the Campinas region reveal important trends. First, agricultural employment dropped from 24 thousand in 1970 to 3 thousand in 1991, accounting for less than 1 percent of total employment (table 5). Simultaneously, large tracts of land in the region were transformed from agriculture into urban-uses such as housing, industrial activities, universities, research facilities and leisure. The second notable trend has been the growth of manufacturing employment from 42 thousand to 118 thousand between 1970 and 1991. As a result of urban and industrial growth, the commerce and service sectors have also grown quite rapidly from 22 thousand jobs in 1970 to 129 thousand in 1991. Although data are not available for previous years, the 1991 data reveal the importance of civil construction and public utilities, employing 47 thousand workers.

TABLE 5
CAMPINAS REGION (1):
OCCUPATIONAL STRUCTURE
1970-1991

SECTOR	1970	1980	1991(*)
Agriculture	24171	19876	3117
Mining	59	66	482
Manufacturing	41877	104278	118293
CC & PU (2)			46656
Commerce	15461	33376	46656
Services (3)	6345	26648	87662
Others			61387
Total	87913	184244	364253

SOURCE IBGE, Censo Industrial, several years. IBGE, Censo Serviços, several years. IBGE, Censo Comercial, several years. IBGE, Censo Agropecuário, several years.

(*) Data for 1991 are based on Ministério do Trabalho - Relatório Anual de Inf. Sociais (RAIS), 1991

(1) Includes the 8 municipalities of Campinas, Indaiatuba, Jaguariúna, Nova Odessa, Paulínia, Sumaré, Valinhos and Vinhedo

(2) Civil Construction & Public Utilities

(3) Including total finance

IV.III - *Development and Structural Characteristics of Manufacturing:*

Since 1970, industrial development in the Campinas region has been primarily based on the growth of intermediate and capital goods sectors. Taking metallurgy, mechanical, electrical and electronics, transport, and chemical industries together, they accounted for 14 thousand jobs in 1970, corresponding to 37% of the total industrial employment. In 1991, this number increased to 70 thousand jobs, corresponding to 59% of the industrial employment of the region (table 6).

TABLE 6
CAMPINAS' REGION: MANUFACTURING EMPLOYMENT

INDUSTRY(3)	1970		1980		1991 (*)	
	Number	(%)	Number	(%)	Number	(%)
Metallurgy	3064	8.3	8226	9.1	13343	11.3
Mechanical	4504	12.2	14090	15.5	11770	10.0
Electrical and Electronics	3065	8.3	8382	9.2	14631	12.4
Transport	1956	5.3	12174	13.4	17536	14.9
Chemical and plastics	938	2.5	5734	6.3	12337	10.5
"Diversas"	736	2.0	2069	2.3	5048	4.3
Others	22584	61.3	40151	44.2	43156	36.6
Total	36847 (1)	100	90826 (2)	100	117821	100

Source: IBGE - Censo Industrial, 1970 and 1980.
(*) Data for 1991 are based on MINISTÉRIO DO TRABALHO, Relatório Anual de Informações Sociais (RAIS), 1991.
(1) Does not include the data that remained closed due to confidentiality requirements.
(2) To make 1980 and 1991 data compatible "unidades auxiliares de apoio"e "unidades auxiliares administrativas" have been subtracted from 1980 data.
(3) Unlike ISIC, the Brazilian classification puts electrical and electronics industries catagory. In addition, most aeronautics
include in "Transportation". The "Diversos" catagory, different from "Others", includes a number of high-tech related activities such as "Surgical and Photographic" devices, and "Miissiles".

Meanwhile, the relative importance of a number of traditional industries such as non-metallics, textile, and food was reduced. Their share in the total industrial employment, between 1970 and 1991, dropped from 37 percent to 19 percent.

Transport, metallurgy, and mechanical industries form the industrial backbone of Campinas. Transport, has been an important part of the industrial mix of Campinas in the past two decades and with the establishment of a plant by Mercedes-Benz in the region, it has become the leading

industry in terms of employment share (Table 6). Employment in metallurgy increased from 3 thousand to 13 thousand between 1970 and 1991. This industry produces intermediate goods with extensive linkages to the capital goods and consumer durable industries in São Paulo state. The mechanical sector had a similar performance with employment in the industry increasing from 4.5 thousand to 14 thousand during the 1970's. Important multinational companies such as Bosch, Clark, Singer, and Schudl are active in this branch. The national economic crisis during the 1980's, had an adverse impact on the capital goods sector with direct influence on the performance of the mechanical industry in Campinas.

The electrical and electronics industry performed as well and with employment increasing from 3 thousand to 14.6 thousand between 1970 and 1991, the Campinas region has been transformed into one of the fastest growing electrical and electronics agglomerations in the nation. Partly influenced by the presence of universities and research facilities, the region attracted many multinational and national firms such as IBM, Ericssson, ALCATEL, Texas Intruments, ABC, and Promon. The expansion of operations by firms already present in the region, such as Pirelli and General Electric, also contributed to this rapid growth.

IV.IV - *Universities and the Research Environment*:

Public institutes performing agricultural research have a long tradition in Campinas. Instituto Agronômico de Campinas (founded in 1887), Instituto Biologico de Defesa Agricola e Animal

(1927), and Instituto de Tecnologia de Alimentos (food technology) (1969) have been instrumental in improving food and farming technologies.

SELECTED INFORMATION ON RESEARCH INSTITUTIONS IN CAMPINAS

Name	Area of Activity	Year Founded	N° of Employers		Ownership
			1988	1994	
CPqD	Research and Product Development in Telecommunications	1976	1491	1241	Federal
CTI	Applied Research and Services in Information Technologies	1984	315	209	Federal
LNLS	Basic and Applied Research in New Materials	1987			Federal
CODETEC	Technology Development and Reverse Engineering - Lately in Pharmaceuticals	1976			Private
OBSER. CAPRICO.		?			
CATI	Technical Assistance in Agricultural Development	1967			State of S. Paulo
EMBRAPA	Research in Agricultural Development	1972			Federal
ITAL	Applied Research in Product Development in food Industry	1969			State of S. Paulo
IAC	Research in Plant Science and Genetics	1887			State of S. Paulo
IB	Basic and Applied Research for Crop Protection	1927			?
CPFL	Energy Research ?	?			State of S. Paulo

Besides PUCAMP, the Catholic university, which was founded in 1942 and today has an enrollment of more than 13.000 students, Campinas' strong political position and its economic and cultural development facilitated the founding of a new State University: Universidade Estadual de Campinas, UNICAMP, in 1962. Unlike other Brazilian universities, UNICAMP, guided by Prof. Zeferino Vaz, emphasized graduate education and research since it started. Prof. Vaz was able to attract respected scholars and researchers from other parts of Brazil and abroad. Within a short time, UNICAMP became one of the most important universities and research centers in Brazil, with 45 undergraduate and 80 graduate programs, and an enrollment level of 14.000 students.

In 1976, influenced by the city's research environment and active lobbying by UNICAMP president and important researchers, TELEBRAS (the state company in telecommunications) decided to locate its R&D center, CPqD, in Campinas. TELEBRAS controls 97 percent of the Brazilian market and has been active in modernizing the nation's services since early 1970's. While in the beginning the focus of CPqD was on products that would substitute for imports, in early 1980's CPqD shifted to emerging technologies such as fiber optics and digital switching. Until 1994, the center had transferred more than 83 products to 77 enterprises and had developed extensive relations nationally and internationally. In recent years some 1.300 employees (of which 800 are researchers) have worked at CPqD, and in 1995 the organization claimed a budget of US$ 115 million.

Another important R&D center in Campinas has been the Fundação Centro Tecnológico para Informática - CTI, established in 1983. A number of years after the declaration of "market reserve" in micro-computers CTI was founded to provide an R&D focus for national firms. CTI reached its highest budget and employment levels between 1986 and 1988 when its budget was US$20 million and 170 researchers worked at the center. But since then the impacts of economic crisis, abandoning the "market reserve" policy, and the center's difficulties in defining a different mission for itself in the new circumstances have resulted in loss of prestige, budget and personnel.

The other important high-technology related research center, with promising technological applications, that was attracted to Campinas is the Laboratorio Nacional de Luz Sincroton - LNLS, established in 1987. This laboratory which will be completed by 1996 will be the only particle accelerator lab in the Southern hemisphere. Other important research institutions such as Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA, have also located various research facilities in the Campinas region.

Together, the existence of the above universities, research institutes, the availability of skilled manpower, the diversity of its industrial mix, proximity to São Paulo, and local conditions transformed the Campinas region into an attractive area to locate high-tech industries. Major high-technology, multinational firms, established production facilities in the region (IBM in 1970; Texas Instruments in 1973; Fairchild in 1974; and HP in 1975). Concomitantly, close to 50 Brazilian

companies in high-tech related production activities, have also located in the region.[4] During the 1980's, with the crisis in the Brazilian economy, and the enforcement of the "market reserve" in informatics and protective tariffs in other areas, multinational companies stayed away and did not develop new facilities in Brazil. In 1994, after trade liberalization, Compaq, the world's largest PC maker, began production in Jaguariúna, within the Campinas region. It is expected that in 1995 two companies, Compaq and IBM, will produce around 800 thousand computers, approximately 80 percent of the present Brazilian market. Since the Brazilian market will grow, these companies also have plans to expand. COMPAQ plans to improve sales from US$250 million in 1995 to US$1 billion by the year 2000. IBM plans to retain its present share of the market which is around 40 percent[5]. There is also the strong possibility that other multinational companies, like Olivetti, Motorolla, and Samsumg would open production facilities in the region.

IV.V - *Linkages in High Technology*:

Technologically mature sectors do not have strong linkages with other industries in the region since they are buying from and selling to the national, and in some cases to international markets. For example, we found that the two biggest firms, Mercedes Benz and Bosch, purchased 2% and 10% of their components in the region. Meanwhile they bought most services and complementary goods in the region. Considering their size, the impact on the economy of the region is quite important.

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[4] The list by CIATEC has 42 companies in 1992, and another list by Torkomanian (1991) provides 46 companies.

[5] Based on interviews at each firm.

The picture in high-tech industries of Campinas is a rather different one. In telecommunications, the presence of CPqD has attracted a number of multinational companies, such as ALCATEL, and ERICSSON, and Brazilian firms such as ABC, SID, and PROMON to the region. CPqD counts some fifteen companies as spin-offs. The state monopoly of the industry guarantees a stable demand, and technical specifications are developed and then enforced by CPqD. As such many companies prefer to have their R&D facilities and, if possible, production units in Campinas. Technologies are developed inside CPqD and then transferred to private firms. Usually this technology transfer is materialized by the hiring of the entire team in charge of developing the technology by the interested firm. As such the relationships between CPqD and the firms in Campinas are quite close. In such an arrangement since the investment requirements and start-up costs are quite prohibitive, only MNCs and large Brazilian firms have been able to participate and, for the most part, one cannot observe the proliferation of small firms[6]. The open question about the telecommunications industry in Brazil is the Federal Government's intentions with regards to privatizing the state monopoly. In case the industry is privatized, the impact on CPqD and its network in Campinas can not be inconsequential.

In the informatics and computer sectors, the decision to open the Brazilian market and to abolish the informatic's law, has weakened local linkages. For example, prior to changes in trade policy,

[6] CPqD conducts projects solely for the operating companies of TELEBRAS. As such the make-up of the telecommunication complex is quite different from the one in Santa Rita do Sapucai where small firms produce for the consumer telecommunication market.

IBM had developed a network of domestic suppliers, the number of which reached 598 firms in 1987. At the time, this pattern was heralded as a progressive form of cooperation between MNCs and domestic suppliers and became a model for a number of other firms in various industries. Presently (in 1995), this number has been reduced to less than 100 suppliers and IBM's purchases on the domestic market have dropped from US$132,4 million in 1990 to US$46,4 in 1994. Similarly, for 1995, COMPAQ has sales provisions of US$250 million and imports of US$150 million. Since the Brazilian market is expected to grow rapidly, these firms will increase production with higher levels of imports. This is because the requirements for economies of scale and the present excess-capacity in the industry internationally, make the establishment of production facilities by component makers in Brazil unattractive.

IV.VI - *Impacts of the Economic Reforms*:

Brazilian industrial production grew, specially from 1930 to 1990, in a closed market that protected the national producers against foreign competition through high levels of tariffs, even import prohibition of a list of goods that included TV sets, other consumer electronics, cars and other products (CACEX, annex 4). In 1983, under the informatics law, imports and MNC production of PCs were banned. In 1990, these protective tariffs were gradually lifted and average import-duties have dropped. Additionally, the creation of MERCOSUL, between Brazil, Argentina, Uruguay and Paraguay, obliges these nations (with exceptions in some areas) to adopt common import-duties. The combined impact of these initiatives have been noteworthy: from 1990 to 1994, annual imports

increased from US$21 billion to US$34 billion. As a consequence, a number of goods produced in Brazil have lost competitiveness, mainly in the high-tech related industries.

Reaction of firms to market reforms in Campinas has been diverse. A number of companies such as Texas Instruments and Fairchild, have decided to close their operations in Campinas and service the Brazilian market from other facilities. Others, such as IBM, have increased importing microeletronic components and other inputs. High technology-related domestic firms face a very difficult situation. Their growth was directly linked to the protective environment of the 1980s and many have not been able to adjust to the new circumstances. Out of 42 firms that appeared on a previously-mentioned list[7], more than 10 firms have closed down.

In terms of technological acquisition, there is a visible move on the part of large-scale Brazilian firms such as Promon, to join ranks with MNCs in order to have access to state-of-the-art technology. Consequently, R&D budgets and personnel are decreasing. This raises an important question regarding the future of high-tech activities in Campinas: Will the R&D capacity in hardware and software and, as a result, inter-industry linkages also improve or will the region become an assembly platform for the MNCs? In hardware, the most probable scenario is that Campinas will increase its role as an assembly platform with weak supply links to national and local industries. On the other hand, the software industry appears more promising. Supported by

[7] Torkomanian (1991)

SOFTEX 2000, CTI, and marketing facilities in the US, the industry can play a more positive role in the region's economy.

V - SÃO JOSE DOS CAMPOS: THE HOPE OF MILITARY AND THE BASTION OF CAPITAL-LABOR CONFLICT

V.I - *Historical Background and Locational Attributes*:

The city of Sao Jose dos Campos, lies in the Paraiba Valley along the Dutra Highway which links the metropolitan areas of Sao Paulo and Rio de Janeiro. The city is located at a distance of 90 km from the former, 310 km from the latter, and 140 km from the port of Sao Sebastiao. Such relatively short distances were the main reason for the original settlement of the area and the introduction of coffee plantations during the first half of the nineteenth century.

However, the westward movement of coffee left the less productive farms of this region in a precarious economic situation. Lack of further development in the area turned those settlements into "dead cities" (Pacheco 1992; Castro 1971). During the first four decades of the twentieth century there were no major changes in the economic situation. Cattle-raising became the primary occupation of the residents and the city experienced loss of population between 1920s and 1940s.

After the Second World War, the Brazilian military launched a program to develop modern technological capabilities in order to modernize its ranks, particularly in aeronautics industry. Taking MIT as the model and inviting consultants and professors from that institution, the Brazilian air force located the first proposed institute, an umbrella research organization - CTA (Centro Tecnologico Aeronautica) in Sao Jose in 1945. The first priority was the development of human resources and ITA (Instituto Tecnologico de Aeronautica) was founded in 1950 to perform that task. SJDC was chosen primarily because of its location on the Rio-Sao Paulo axis, and the availability of electrical power, pleasant climate, and fine topography (Medeiros and Perilo 1990).

This was a momentous decision that changed the future course of development in SJDC. With the success of ITA in recruiting and training the necessary human resources, CTA's other institutes were founded in the following years and, together, with help from other research institutes such as IPT - (Instituto de Pesquisas Tecnologicas) in Sao Paulo, they succeeded in the design, production, and testing of aircrafts and started the state-controlled company, EMBRAER, in 1969. Concomitantly, the government expanded its projects to the related field of aerospace research and INPE (Instituto de Pesquisas Espaciais), the organization in charge of the program, was founded in 1961.

With the commitment of the military and national government to the area and the subsequent development of human resources and infrastructure, Sao Jose dos Campos (SJDC) became an

important locational choice for manufacturing. Before 1950 the two important plants in the area were a textile plant and the branch plant of a chemical MNC (multinational company). But since then, several MNCs such as J&J, General Motors, Ericsson, Philips, and Kodak located in the city. In addition to human resources and infrastructure, the availability of water and low-cost land, and the rapid industrial expansion of the city of Sao Paulo and the ABC area (in the metropolitan area of Sao Paulo), reinforced the locational attractiveness of SJDC. The subsequent success of EMBRAER in exporting its civilian and military aircrafts and the expansion of its operations, resulted in a number of Brazilian firms in aeronautics and military-related industries to locate in the city.

In spite of a remarkable success particularly in the areas of technological acquisition and export of high-tech related products, changes in international affairs, in national macroeconomic environment, and internal problems of the leading firms in the city during the 1990's have resulted in a major downturn in the city's economy. Such an erratic developmental path indicates that although generating growth is important, the concomitant development of the institutions and social structures that could assist the adjustment process are as important.

VII - *Population Growth and Occupational Structure in SJDC*:

The general picture of the city's development had been enviable. Urban population increased from 148 thousand to 442 thousand inhabitants between 1970 and 1991 (table3). Changes in the city's

occupational structure indicate a number of important trends (table 7). First has been the radical reduction in the share of agriculture from 17 to 1 percent of the overall employment between 1970 and 1991.

TABLE 7
CITY OF SÃO JOSÉ DOS CAMPOS:
OCCUPATIONAL STRUCTURE
1970-1991

SECTOR	1970	1980	1991 (*)
Agriculture	4746	4172	1444
Mining	80	57	136
Manufacturing	17866	45067	46277
CC & PU (1)			3842
Commerce	3243	8776	12345
Services (2)	1816	7501	21101
Others			22223
Total	**27751**	**65573**	**107368**

SOURCE IBGE. Censo Industrial. several years IBGE. Censo Serviços. several years.
IBGE. Censo Comercial. several years IBGE. Censo Agropecuário. several years.
(*) Data for 1991 are based on Ministério do Trabalho-Relatório
Anual de Inf. Sociais (RAIS). 1991
(1) Civil Construction & Public Utilities
(2) Including total finance

The second important trend was the rapid increase of employment in manufacturing. Unlike other urban centers in developing economies, manufacturing employment increased at a faster rate than population, growing more than 10 times between 1960 and 1991 (table 8). A large number of jobs were also created in other sectors as the lure of employment opportunities in manufacturing and the concentration of a relatively large number of high-salaried employees contributed to a rapid pace of

urbanization. The growth in services and commercial activities was remarkable, continuing through most of the 1980's.

V.III - *The Development and Structural Characteristics of Manufacturing*:

The first wave of investments in SJDC, during 1950's and 1960's, was primarily linked to MNCs in auto and consumer goods industries. Investments by GM, Eaton, J&J and further expansion of Rhodia's operations account for the emergence of transport as the leading industry, followed by chemicals in 1970 (table 8). The importance of transport, chemicals, as well as textiles and apparel (with 2326 and 2905 employees[8]) point to the importance of mature industries in the industrial mix of SJDC.

TABLE 8
SÃO JOSÉ DOS CAMPOS: MANUFACTURING EMPLOYMENT 1960-1991

	1960	1970		1980		1991	
Industry	Numbers	Numbers	(%)	Numbers	(%)	Numbers	(%)
Transport	- *	3960	22.3	9110	23.6	20266	43.9
Mechanical	- *	452	2.5	5224	13.5	2010	4.4
Eletric & eletronics	341	1280	7.2	5906	15.3	7404	16.0
Chemical & plastic	1205	2615	14.7	2054	5.3	4414	9.6
Diverse	- *	842	4.7	1661	4.3	4098	8.9
All others	- *	8637	48.6	14636	37.9	7946	17.2
Total	6003	17786	100	38591	100	46138	100

Source IBGE - Censo Industrial Data for 1991 are based on MINISTÉRIO DO TRABALHO, Relatório de Informações Sociais (RAIS), 1991

(*) Data are not avaible or include closed data for some sectors due to Census rules regarding single enterprise confidentiality

[8] Source IBGE, Censo Industrial, 1970

The second wave of large-scale investments, made by the military and national governments, was responsible for the emergence of specializations in aeronautics, and military-related activities (see the next section). These large-scale public investments, availability of the required infrastructure and high-level manpower, attracted a third wave of investments by MNCs primarily in Electrical and Electronics industries and "Diverse" activities. Ericsson, Panasonic, National, Philips, and Hitachi were in the first group, and Kodak, and J&J primarily in "Diverse" activities which were developed during the 1970's. The growth of the Mechanical sector was mostly due to the operations of a single firm, "Elevadores Kone".

Such large-scale investments shaped the most important structural characteristics of manufacturing in SJDC: the dominance of large establishments (more than 500 employees). One study shows that, throughout the 1980's, some 20 large establishments, representing less than 5% of the number of establishments, accounted for 80 to 85 percent of employment, with their share falling to 75 percent in 1992.[9]

V.IV - *Sao Jose dos Campos as a High-Tech Military "Technology Pole"*:

Since early 1970's, SJDC has been one of the important centers of high-tech activities in Brazil. With the creation of ITA, the city was able to recruit highly qualified scientists and engineers from

[9] Prefeitura Municipal De Sao Jose Dos Campos. 1994. "Industrias de Sao Jose Dos Campos," Secretaria de Planejamento e Meio Ambiente Sao Jose Dos Campos

other parts of Brazil, and internationally, while emphasizing the development of human resources at the local level. During the 1950's and 1960's, ITA became the most prestigious engineering school in Brazil, attracting the best talents in the nation. CTA successfully anchored the military's plans by creating the necessary institutional vehicles. The most important one, IPD - Instituto de Pesquisa e Desenvolvimento (Institute for Research and Development) was created in 1954. During the 1960's IPD performed a number of projects, of which the most crucial one was the development of the prototype of Bandeirante that was later built by EMBRAER (Medeiros and Perilo 1990). CTA's other institutes such as IAE (Instituto de Atividades Espaciais), IFI (Instituto de Fomento e Coordenação Industrial), and IEAv (Instituto de Atividades Avançada) were created in 1973, 1974, and 1980 respectively.

The space research center, INPE, has also played an important part in the emergence of the aerospace specialization in SJDC. Starting in 1961, the institute was able to recruit, at its peak, up to 1000 highly qualified professionals. It has ongoing projects with more than eight other nations and in 1993, launched the first Brazilian-built satellite in cooperation with NASA. Although attempts have been made to transfer the technology developed at INPE, the results have not been satisfactory (combustion and Plasma technologies and software products were mentioned) and the number of spin-offs have been very limited[10].

[10] Interviews conducted at INPE indicated that the "technology transfer unit" was recently closed and that less than five viable firms could be counted as spin-offs

Since the creation of R&D institutes was mission-oriented, the results were primarily transferred to a newly created firm, EMBRAER. In addition during 1970's and 1980's, Embraer benefited from military's procurement policies and governmental subsidies in financing its sales, while it capitalized on the design and integration capabilities of its human resources. The firm successfully developed civilian and military aircrafts for international markets and its sales reached US$171 million in 1980 and improved to its peak of US$700 million in 1989.

Along side the aeronautics industry, other projects by the military either started or attracted a number of companies interested in the production of military equipments to the city. Avibras started the production of missiles and launchers, and Engesa developed tanks and armored vehicles. Certainly, the accumulated knowledge about, and contacts with, the militaries around the world and the Brazilian military's procurement policies helped these firms to grow quite rapidly. The following companies constituted the core of the high-tech/military complex in SJDC:

TABLE 9
PROFILE OF DEFENSE-DEPENDED ENTERPRISES IN SÃO JOSÉ DOS CAMPOS
1987 DATA

Name of Enterprise	Establi-shed in	Main Products	Created by	# of Employees	Exports as a (%) of sales	% Sales to Government
EMBRAER	1969	aircrafts	CTA Planners	9027	65	21
AVIBRAS	1961	missiles	Reseachers from CTA	5000	98	2
ENGESA	1975	tanks & APC	Outside firm	2500	more than 90	less than 10
TECNASA	1962	eletronics	Researchers from CTA	502	-	more than 50
AMPLIAMATIC	1964	eletronics	Outside firm	439	0	0
ORBITA	1987	missiles	Consorcium of firms	250	-	-
COMPOSITE	1981	new materials	Researchers from CTA	105	0	more than 80
ABC	1984	eletronics	Outside firm	69	0	100

As can be seen from the table 9, more than 50% of the companies were created by researchers from CTA while others are private firms. A previous study, which included a more comprehensive list of firms, indicated that twelve out of fifteen firms that produced hi-tech/defense related products were

founded by CTA and INPE personnel[11]. Interactions among these scientists and engineers who mostly studied and researched together, created a cooperative atmosphere among firms, ITA, and R&D centers. High spill-over effects have been visible and exchange of information have found many routs other than formal market relations.

The limited number of firms and the relatively large size of core enterprises are indicative of strong entry barriers and the vertically integrated character of the firms.[12] Basically, the large, diversified Grupos and highly specialized large firms such as ABC, and Engesa were able to enter this environment. With regards to sales, it is important to point out that whereas EMBRAER, AVIBRAS, and ENGESA were heavily export-oriented, the others were primarily Embraer suppliers and as such depended on its purchases.

V.V - *Linkages*:

The industrial structure of Sao Jose Dos Campos (SJDC) has three main components: the aerospace/military industries, MNCs, and the local traditional industries. In this section we present an account of the nature of linkages within and between these sectors.

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[11] Tromboni, P., Nascimento, S., and Perilo, S. 1991. "A Technologia Como Condicionante do Perfil de um Polo Tecnologico O Caso de Sao Jose dos Campos," XVI Simposio Nacional de Pesquisa de Administracao em Ciencia e Tecnologia, Rio de Janeiro.

[12] This point was emphasized during interviews.

In the aerospace sector, there are strong interactions among firms, educational and R&D centers The linkages are particularly strong at the R&D level with many firms using the research and testing facilities at CTA and EMBRAER. After 1975, Embraer in cooperation with CTA, developed a network of suppliers. A number of small and medium sized firms were thus established among which the most important ones were TECNASA[13], ABC-Dados, AMPLIAMATIC, ORBITA. and COMPOSITE in SJDC and others in Sao Paulo Region. Additionally, by subcontracting part of its machining, tooling, and similar tasks Embraer's contracts in the area of SJDC added up to US$30 million in mid-1980s. Although the emergence of the above companies certainly improved EMBRAER's "nationalization Index", the small orders and the associated high costs. did not allow them to compete on international markets, turning a majority of them into captive suppliers of EMBRAER.

But considering the larger picture in the industry, we realize that in spite of a number of local linkages. the aeronautics industry in Sao Jose dos Campos is highly embedded in international networks Close to 80 percent of EMBRAER's equipments and machinery, and 75 percent of its components are imported[14]. In recent years, Embraer has increasingly relied on outside partnerships as a risk-sharing measure to the extent that in its latest product, the 50 passenger jet, the company has developed a Consortium-like international network that will advance more than 1/3 of the R&D costs in return for future parts and components contracts.

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[13] TECNASA, a private firm, had already been established in 1962 by graduates of ITA.
[14] Questionnaire filled out by Embraer.

The companies producing military products, Avibras and Engesa, were highly vertically integrated firms. Whereas, Engesa relied heavily on in-house design and technology and had close linkages with the auto-parts industry in the Sao Paulo area, Avibras was highly dependent on US components, particularly in electronics. The rapid growth of these companies was related to their success in Third World markets, particularly in the Middle East.

The other sector that is heavily represented in SJDC is the MNC branch-plants. Branch-plants generally depend on their parent companies for significant shares of their equipments and parts, technology, training, and financing. We found this to be true among branch plants in SJDC. Their local linkages are extremely weak although GM, Philips, Kodak, and Ericsson, reported strong linkages to the Sao Paulo area. Their contribution to the growth of employment in the area has been substantial: in the mid-eighties they were responsible for more than 20,000 jobs in the city. It also needs to be recalled that their role in the present growing unemployment has been substantial as well (see later). In terms of sales, MNCs, except for those in the auto-parts sector, basically produce for the Brazilian market and only since the trade liberalization have a number of them targeted external markets.

V.VI- *Technopole in Distress*:

"We are the victims of the peace explosion."
(Juarez Wanderley, EMBRAER's present President)

In spite of the remarkable performance of the city during the 1970's and most of the 1980s, Sao Jose dos Campos has been facing tremendous difficulties during the last few years. Both external and local causes have contributed to this situation. Globally, the restructuring process has caused important shifts in strategies followed by MNCs, while dramatic political changes have reduced the demand for military products produced at SJDC. Nationally, Brazilian society has been democratized, reducing the importance of the military and support for military-related industries at the same time that the economy has experienced various market reform policies. Locally, the business failures of the leading firms in the area, the negative consequences of segregation between the military and civilian sectors of the city, and the emergence of a radical labor movement have deepened social cleavages and dampened community-wide efforts to confront the new challenges.

First, the impact of global processes on Sao Jose dos Campos has been remarkable. The restructuring in the aeronautics and air-transportation industries has forced Embraer to struggle with repeated cancellations and to shelve important projects, towards which more than US$500 million had been spent. In other industries, firms have been downsizing either by closing certain product lines or through outsourcing. Ericsson, Rhodia, and Kodak have reduced their work-force by 25 percent. The latter stopped its camera production-line when the parent company decided to assemble cameras for both North and South American markets in Mexico. Philips has plans to produce components in other regions of the country. All large firms, national or branch plants, reported efforts in "core-business consolidation", resulting in extensive outsourcing in such services

as site maintenance, transportation, catering, security and machinery upkeep. In few cases, parts production has also been moved out of the firm.

At the same time, the reduction of military budgets internationally and the end of the Persian Gulf war have basically shut producers of military equipment in Sao Jose dos Campos out of the internacional market. The results have been dramatic. Embraer's military-related sales (domestic and international) dropped from US$282 million in 1989 to less than US$125 million in 1993[15]. Engesa has closed down entirely and Avibras has moved to other fields, resulting in approximately 9,000 direct lay-offs in these two companies.

In terms of national macro-economic environment, the changes have also been important. Trade liberalization has forced companies to face new competition and has done away with major emphasis on domestic content requirements. The other important policy has been privatization which has been applied to the "hub" company in the city, the Embraer, in 1994. As a badly-managed public enterprise, Embraer had accumulated a total of US$1 billion in debts. The Brazilian budget crisis and the changes in the role of the state and the position of the military made it difficult for Embraer to rely on governmental financing as it did in the past. Once the anchor of Sao Jose dos Campos' growth and prosperity, the company's external and internal problems turned it into a destabilizing force in the city's economy. Embraer has reduced its work-force from the peak

[15] Flap International: Edicao Especial, June 1994.

of 12,500 in 1989 to the present level of 4,300 with more dismissals planned. Its domestic suppliers in the area are in deep trouble: TECNASA, ABC-Dados, Ampliamatic and a number of smaller companies have shut down. All of its subcontracting work has been brought back "in-house", resulting in a further 1,000 lay-offs[16].

At the local level, the military culture that prevailed for two decades, segregated the aerospace complex from the city. At the same time, the importance of large and multinational firms in the manufacturing structure of the city (employing 80% of manufacturing workers) and the high rate of immigrant labor provided a fertile ground for the emergence of a highly radicalized labor movement. This labor movement has had the unenviable job of being confrontational in order to raise wages and prevent massive lay-offs on one hand, and being cooperative enough to prevent the exodus of future investments on the other. Repeated lay-offs and job insecurity has strengthened the union as welll. Labor unionization rate for the city has increased from 27.7% in 1980 to more than 40% in 1991 and even higher since then. According to figures published by Municipality of Sao Jose dos Campos, the city's manufacturing sector, at its peak in 1988, employed more than 64,000 workers[17]. In 1994, this figure was reduced to 45,000 with more loss of jobs since then. The transportation, electrical-electronics, and "Diverse" industries, with 5,500, 4000, and 4,000 job-

[16] Interview with Juarez Wanderley, presently Embraer's president.

[17] Prefeitura Municipal De Sao Jose Dos Campos, 1994, "Industrias de Sao Jose Dos Campos," Secretaria de Planejamento e Meio Ambiente Sao Jose Dos Campos. Preliminary data for 1994 were provided separately by the municipality at the request of authors

losses have been the most affected sectors. There has been various initiatives to stop this downward spiral: an incubator for high-tech start-ups, opening the CTA's airport to commercial activities, and other plans. But none have moved forward and it seems that community- and class-based divisions are so deep that developing institutions and policies that could bring the community together and out of the present economic debacle are quite difficult.

VI - CONCLUSION:

A brief review of the Brazilian industrial and regional changes indicated that rapid industrial development during the present century lead to a strong process of regional concentration in the São Paulo Metropolitan Area. The more recent deconcentration process has not generated broad macro-spatial shifts in economic activities and has remained confined within a macro-region stretching from the center of Minas Gerais to the northeast of Rio Grande do Sul. This macro-region has captured the emerging high-technology industries and as the experience of Campinas and São José dos Campos exhibited, proximity to São Paulo remains important for Brazilian R&D establishments and manufacturing firms. This pattern is different from advanced industrial nations such as the US, where high-technology industries have emerged far from the traditional centers of manufacturing, generating visible macro spatial shifts in economic dynamism.

In addition to proximity to São Paulo, other similarities, as well as differences, can be detected when the developmental paths of Campinas and São José dos Campos are compared. Both cities experienced rapid population and manufacturing employment growth during the last three decades. Support of the Federal and State governments has been central in the growth process of both cities. The Brazilian military chose São José dos Campos as the site for developing what it considered strategic industries and technologies. As a result, dependence on the military was direct and included investment, procurement, and financing support for a limited number of firms as well as educational and R&D facilities. There was a strong emphasis to penetrate export markets. In Campinas on the other hand, high-tech industries were directed towards the domestic market in what has been called the "import preemption" approach to industrial policy (Hirschman, 1988). The government's intervention was quite comprehensive in the computer industry up to 1990 when market reform policies were adopted and "informatics law" was revoked, and its policies still shape the telecommunications industry.

Industrial mix and industry structures in both cities have developed differently. São José dos Campos evolved on the basis of a limited number of industries with skewed industry structures in favor of large domestic and multinational firms. The mix of industries in Campinas has been diverse and, in general, industry structures, though dominated in several industries by MNCs, have never-the less been less skewed, with medium and small firms represented.

Again, similarities, as well as differences, were observed in various labor market segments in our case studies. In both cities professional human resources emerged through specialized local universities complemented by in-migration from other urban centers in the nation as well as from the exterior. But in skilled and unskilled labor segments we see important differences. In Campinas labor market in these segments was more local whereas in São José dos Campos in migrants dominated. In São José, the syndicates are quite radical and confrontational, and strikes have been common throughout the past decade. In Campinas syndicates have remained rather quite, and strikes are rare.

Among various linkages that have characterized industrial development in Campinas and São José dos Campos two types were considered: linkages within high-technology sector, and linkages between high-tech and mature industries. In São José dos Campos strong linkages, particularly at the R&D level, were observed among high-technology firms and between those firms and the R&D and educational centers. In addition, a limited local supplier network was developed around EMBRAER which did not improve the firm's flexibility in facing the industry's restructuring and cycles in defense spending. In Campinas, the telecommunications industry exhibited strong interactions between the national R&D institute and firms, but not among the firms themselves. We believe that such strong interactions have been due to the nationalized character of the market's eventual privatization will loosen those linkages. The domestic and local linkages within other high-technology industries in Campinas were rather significant prior to market liberalization and

repeal of the "informatics law" in 1990. Since then small suppliers have gradually disappeared as MNCs and a very limited number of domestic firms have moved to dominate the market and shed their domestic suppliers in favor of global supply networks and technology partners.

In both cities we found the linkages between high-technology and mature industries to be weak. We did not observe any public agencies actively promoting technology diffusion, nor did we come across large domestic conglomerates (except in one case) pursuing systematic transfer of high-tech to other operations within the firm. São José dos Campos is a classic case of failure to convert from military to commercial activities and the "enclave" nature of high-tech industries and its isolation from other industries contributed to that failure.

In socio-cultural terms we found that the high-technology industry's development in São José dos Campos was embedded within a military culture, segregating employees of these industries from the city. Industry structure, immigrant labor, massive lay-off and, strong syndicates have also load heightened class. Thus strong social segmentation and lack of collective institutions have reduced the community's capacity to face the difficult crisis that has engulfed the city over the past few years. The future prospect for the city is not proeminent. The defense sector will never be a major employer in the city, taking the international and Latin American political environments, and for positive steps to be taken two core institutions in the city will have to undergo a radical transformation: the aeronautics complex should become successful again and be socially integrated

into the city, and the syndicate will have to change its extremely confrontational tactics and begin to think long-term.

Campinas does not suffer similar institutional, social and class segmentations, although one can observe problems associated with unequal distribution of income. Local boosterism has been quite a significant force in Campinas and the city has been making a concerted effort to face the new open economy. Its prospects are better than São José dos Campos and the city will continue its role as a major pole for R&D in various industries, particularly in software, and for production and assembly of various high-tech industries. The recent decision of Compaq to come to the region will probably be followed by other major firms such as Motorola, Samsung and others.

What implications can the study of these cities have for regional policy? First, the two case studies showed that regional policies based on the development of high-technology agglomerations should be closely coordinated with national industrial and trade policies. In the case of Brazil this was closely related to national defense priorities as well. Secondly, it was exhibited that unless large-scale state interventions are coupled with local initiatives, localities become extremely vulnerable to political changes and shifts in trade and industrial policies.

Third, we can conclude that in the absence of complementary industrial and trade policies, as well as local initiatives, development of high-tech enclaves will not generate the necessary spread effects and should not be adopted as vehicles for regional development.

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